A view of the history of biochemistry in India*

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History relates to conquests and defeats and to successes and failures of human activity. It is about places, people and progress. It takes different forms according to the knowledge and perceptions of historians. A failure for one is a strategy for another. A success highlighted by one, is ordinary for another. It can be twisted, distorted and fixed. It can inspire and make you feel good. Being associated with developments in biochemical research and education for over five decades, I wish to recall some personalities, laboratories and incidents, and present my view on the developments, including the impact of scientific journals and the Society of Biological Chemists (India) (SBC). The session on the history organized by SBC missed Burmaji, as I fondly called D. P. Burma, who did most for recording the history of biochemistry in India[1]. We did not have to depend on a Chinese traveller or a British colonial.

Early phase

Fermentation of sugar syrup by yeast cell-free extract discovered by Buchner in 1897, marked the beginning of biochemistry[2]. In just 11 decades, it leaped a long way and is galloping in its survival avatars of molecular biology, genetic engineering and biotechnology, and possibly systems biology next. Has biochemistry ceased to exist in the early 1990s along with communism (!) as Sydney Brenner[3] remarked? Is it a form of differentiation or apoptosis in one century? No. Biochemistry is not dead – long live Biochemistry. Borrowing from Dalrympole (of *The Last Mughal* fame), we have certainly not yet seen 'The last biochemist'.

Biochemistry has been popular in India for over eight decades, more as applied chemistry/biology in the early phase. It is interesting to know how biochemistry evolved in India. Several questions can be asked. Which was the first biochemistry department for research and which university started teaching biochemistry? Who obtained the first Ph D in biochemistry? Who did the first enzyme assay? Who did the first experiments with radioactive tracers? Who did the first protein sequence and nucleic acid sequence? Who did the first restriction analysis and obtained the first recombinant protein and so on? What are our contributions – discovery of an enzyme, metabolite, vitamin, hormone, drug, pathway, or a phenomenon? It is time to feel good for the little things we did first, which later became fashionable in the world. It is time to remember the pioneers who dared to open up new frontiers. Information on the achievements in biochemistry in India is awaited in a book on history started by Burma, now under completion by his wife, Maharani.

The first departments

Department of Biochemistry was started in 1921 at the Indian Institute of Science (IISc), Bangalore. The first Professor, Gilbert J. Fowler, a British biochemist, introduced his specialty, biological treatment of wastewater, and also food technology, nutrition and enzymology. In a lighter vein, it is remarked that biochemistry entered through the drain, kitchen and tummy. Research had been its prime objective all along. I am happy to have been associated with it for over five decades. To Nagpur University goes the distinction of starting in 1947, the first biochemistry teaching course leading to the M Sc degree.

Places

Before independence (15 August 1947) hardly a handful of research institutions existed in India. Research was carried out in the universities in Calcutta (now Kolkata), Bombay (now Mumbai), Madras (now Chennai), Nagpur and Allahabad largely due to the initiative of the professors. Reluctance to start full-fledged departments is understandable because growth and potential of the subject was difficult to comprehend in the early 1950s. Breaking away from chemistry in the universities and from physiology in medical institutions was difficult. Research and development laboratories were scarce. Nutrition Institute (Coonoor), Haffkine Institute (Bombay), Institute of Hygiene and Public Health and Institute of Experimental Medicine (Calcutta) are some examples. We owe to the vision of Jawaharlal Nehru, our first Prime Minister, rapid expansion of scientific research through large funding, initially through Council of Scientific and Industrial Research (CSIR) and the Atomic Energy Commission (AEC), New Delhi. In the wake of this activity, biochemistry benefited and facilities for biochemical research became available in many institutions: National Chemical Laboratory (NCL), Pune; Central Food Technological Research Institute (CFTRI), Mysore; Central Drug Research Institute (CDRI), Lucknow; Central Leather Research Institute (CLRI), Chennai; Industrial Toxicology Research Centre (ITRC), Lucknow; Indian Institute of Chemical Biology (IICB), Kolkata under CSIR and Bhabha Atomic Research Centre (BARC), Mumbai; Tata Institute of Fundamental Research (TIFR), Mumbai and Cancer Research Centre (CRI) under AEC. Some of the active biochemistry laboratories had difficulty in holding on to these institutions, until the flood of modern biology that swept across the world in the 1970s had its beneficial effects in India. New-wave research laboratories came up with facilities comparable to those in international laboratories, starting with the Centre for Cellular and Molecular Biology (CCMB), Hyderabad and National Institute of Immunology (NII), New Delhi. High-profile research in biochemistry and modern biology is now possible in a large number of institutions: CCMB, NII, BARC, TIFR, IICB, Institute of Microbial Technology (IMTECH), Chandigarh; International Centre of Genetic Engineering and Biotechnology (ICGEB), New Delhi; Institute of Genomics and Integrated Biology (IGIB), New Delhi; National Centre for Biological Sciences (NCBS), Bangalore; Centre for DNA Fingerprinting and Diagnostics (CDFD), Hyderabad; National Centre for

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Cell Science (NCCS), Pune; National Brain Research Institute (NBRI), Manesar; Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bangalore; departments in biological sciences, in IISc, some universities, and others. Indian Council of Agricultural Research (ICAR), New Delhi has an institute almost for each important crop. Defence Research and Development Organization (DRDO) matched with a large number of institutes in their areas of their interest. It is important to give credit to agencies such as University Grants Commission (UGC), CSIR, AEC, Indian Council of Medical Research (ICMR), ICAR, DRDO and others, and later Department of Science and Technology (DST) and Department of Biotechnology (DBT) for support and creating new centres of research.

People

I do not know about the pioneers in the first three decades who braved to open new areas not fashionable then. As a student I have heard of the names of giants of that time: B. C. Guha, M. Damodaran, V. N. Patwardhan, V. Subramanian, K. V. Giri and M. Sreenivasaya (the first to assay an enzyme, amylase in an Indian laboratory). Guha discovered a new enzyme, gulonolactone oxidase. Radioactive tracer work was initiated in Calcutta in 1953 (S. K. Roy, D. M. Bose and B. B. Biswas, P-32 and S-35) and in Bangalore in 1956 (K. V. Giri and T. Ramasarma, C-14). My guru, Giri set an example of working at the bench, staining his hands doing circular paper chromatography and gel separation of proteins in the 1950s. What a difference it would have made if only he had known polyacrylamide! Inspired by this I gave agar gel circles to Amba Rao, Department of Aeronautics, IISc who discovered its photoelastic properties. This yielded a note in *Nature* (1955), on which I declined to be co-author. *Nature* was unreachable until the 1970s and a note (1961) therein did not fetch me a job!

In the 1960s A. Sreenivasan, P. S. Sarma and V. Jagannathan contributed to stabilize biochemistry in India. I also remember the contributions of P. S. Krishnan, C. R. Krishnamurthi, T. A. Venkitasubramanian, N. G. Magar, B. M. Braganca, J. Ganguly, H. R. Cama, T. Ramakrishanan and A. G. Datta. New wave stars, P. M. Bhargava, G. P. Talwar, D. P. Burma and B. K. Bachhawat enhanced the image of biochemistry with a shine of molecular biology that became fashionable. With many opportunities created by then came the flood. A large number of committed scientists, too many to mention, earned a place for Indian work at the international level and made a name for themselves, their institutions and the country. More waves followed and the numbers multiplied with increased opportunities. History is happening now in the laboratories all over India. Look at the quality of publications of this generation, creating a huge plateau of high-impact work for spikes of creativity to emerge.

Education

Hardly any comprehensive textbook in biochemistry was available until that of Fruton and Simmonds appeared on the scene in 1957. Compare its contents with the recent ones to see the enormous growth of the subject. Two outstanding findings, DNA double-helix and insulin primary sequence, were announced in 1953. How many can say that they recognized their importance then? An advanced study course in biochemistry was not available in the country. Starting the M Sc course in biochemistry in 1947 with an uncertain future is remarkable and the credit goes to Nagpur University, the far-sightedness of M. C. Nath and the bold students opting for it. Other universities followed. A big leap was achieved during 1959–63 by the UGC-initiated biochemistry review committee led by B. C. Guha, and later by P. S. Sarma. Biochemistry got its due recognition and requirements of staff and laboratory were defined. By 1975, the *University Handbook* listed over 30 universities, including medical and agricultural, that offered Master's programmes in biochemistry. Teaching biochemistry at the B Sc level was not favoured since 'good grounding in subjects like chemistry and biology' was a prerequisite. A rethinking on this occurred in the SBC meeting in Aligarh (1976), recognizing some advantages. Another UGC committee with C. V. Ramakrishnan in the 1980s even prepared the syllabus of B Sc biochemistry and discussed it at a meeting in the University of Delhi South Campus (UDSC). I expressed my dissent. With UGC approval at the B Sc level, biochemistry spread in several colleges all over the country. Then followed M Sc biochemistry in affiliated colleges, ill-equipped with hardly any trained staff and even less laboratory facilities. Euphemistically called self-financing, these have mushroomed by the lure of business, only surpassed by biotechnology in this decade. Respect to quality diminished. But who cares because what is wanted are jobs, social justice, and money. Guha and Sarma would be most unhappy to see this.

We need someone to blame. I am reminded of the memorable reply of the Lilliput king when Gulliver asked him why he needed a minister when he controlled everything: 'I need someone to blame if something goes wrong'. Could not the major universities of Calcutta, Bombay and Madras, now 150 years old, show the way? Why was internal decay of values permitted in universities? It is mind-boggling to see a twisted interpretation of history pointing fingers at the Department of Biochemistry, IISc, 'department failed to provide leadership in the development of proper biochemical education in the country'[4].

Research and Ph D degree

Most of the early scientists went abroad for research, training and doctoral degrees. In 1945, many scientists sailed to the West in military ships returning home immediately after the war ended. Then some diehards in the country worked with professors in university laboratories and submitted their theses. These were sent for evaluation in and out of the country, a long-drawn process, longer than doing the work. M Sc by research, offered earlier, is almost extinct now. After 1950s, the numbers increased along with increase in facilities and funds. Some institutions started selections on competitive basis. Financial support came from UGC, CSIR, AEC and others that freed students from dependence on parents to work for their Ph D degrees. With large intake each year, short preparatory training was found necessary to catch up with the fast growth of biochemistry. Introduced in IISc in 1960, it was resented initially but appreciated by the students in the later years of their career. Some university departments, e.g. in Kolkata and Jawaharlal Nehru University, provided good training and their students are doing well in India and abroad. Like

other teaching programmes, a flood ensued. UGC started another programme, the Faculty Improvement Programme (FIP), with the intention of giving research opportunity to experienced teachers and also a Ph D degree. This ran into social problems with the unrealistic three-year time limit. Some universities, with no record of publishing research papers for years, started to 'produce' Ph Ds to meet with the requirements of promotion of faculty. What use are numbers without quality? On the other hand, output of quality research from CSIR laboratories is obvious. The number of Ph D students enrolled in some of these laboratories is even more than that in a university. Why not give them deemed university status?

M Phil degree

M Sc degree given by the universities was considered not good enough. It is not uncommon that candidates with first-class degree fail to qualify in the entrance tests of UGC/CSIR/State-level tests (NET, SET) and they are not eligible for research scholarships and lecturer positions. Decline in the standards of teaching M Sc in university department is well known. This should have been halted and the quality restored. Instead, a new degree, M Phil was introduced as a preparatory course for research career – an ill-conceived programme doomed to fail. Always under pressure to start a study course in science faculty at IISc, the then Director, S. Dhawan formed a committee consisting of G. N. Ramachandran, C. N. Ramachandra Rao, T. Ramakrishnan, C. K. Ramakrishnakurup and T. Ramasarma to examine the introduction of M Phil degree. It did not take long to decide against this. IISc continued to devote its time for training programmes and workshops of specialized nature, appropriate for a research institution.

Short-term training

UGC and other agencies sponsored a number of summer (and winter) schools for discussion of advancing frontiers, workshops with laboratory component, and refresher courses, based on an idea credited to Humayun Kabir. These flourished during the 1960s and after. Lot of effort, resources and time had to be given by the host laboratory. These are popular with research workers and teachers. Many universities and institutions have contributed to this. I cherished doing several of these at IISc early in 1960s and many that benefited attending these, rose to become Professors, Vice-Chancellors and Directors.

The journals

Scientific journals publishing research articles were started in the early thirties in India: *Journal of Indian Institute of Science* (1930), *Current Science* (1932), *Journal of Indian Chemical Society* (1933), and *Journal of National Institute of Sciences* (1934). However, these journals were less popular. Publishing in British, Continental and American journals gave more exposure and therefore were more sought after, then and now. Nuggehalli Narayana published the first paper from India in the *Biochemical Journal*, UK. Up to the 1960s, publishing in *Nature* was routine from many active centres in India. It became scarce thereafter. Progressively, citation of Indian work decreased, ironically as the quality of the work started to improve. Our papers always found a place in *Annual Review of Biochemistry* every year until the 1970s, and this slowly died down later on. The popular biochemistry journals were *Biochemistry Journal* (UK), *Archives of Biochemistry and Biophysics* (USA), *Journal of Biological Chemistry* (USA) and *Biochimica Biophysica Acta* (the Netherlands) (started in Europe after the war; M. Sreenivasaya was on the first Editorial Board). Then came a flood of specialized and focused journals. Publishing Indian work remains as difficult as ever, despite the wide choice of journals, and more so in high-impact journals. And citable Indian articles are not cited wherever published because of prejudice and indifference. In this connection, it is worth reading the article of Goldstein[5].

Then came CSIR journals in India. A. Krishnamurthi, an alumnus of the Department of Biochemistry, IISc, became the Chief Editor. CSIR was keen to start journals in biology, recognizing its importance. The first was *Indian Journal of Experimental Biology* (IJEB). With P. S. Sarma and A. Krishnamurthi playing a key role, a decision was taken to start the *Indian Journal of Biochemistry* (IJB) with sponsorship of the SBC at a meeting in Hyderabad that I attended as Hon. Secretary of SBC. I am happy that the first article in IJEB (1963) and the second in IJB (1964) came from my laboratory. I continued to send my good papers to IJB, and IJBB (after Biophysics was added) and some of them received unexpected attention such as an invitation for an article for *Encyclopedia of Human Genome* of Nature Publishing Group (2003). A good article will eventually be noticed wherever it is published, what with the modern Internet services.

As Editor, A. Krishnamurthi interacted with leading biochemists in the country and many active workers contributed their good papers to IJEB and IJB. He shared with me his interesting encounter with a leading Indian biologist who told him that the standard of IJB has to be raised before he publishes in it. Instead of improving IJB he lowered the impact of some foreign journals!! Institution of an award in the name of Krishnamurthi by SBC is indeed a good gesture.

The Society of Biological Chemists (India) and education programmes

Started in 1930 in the IISc campus, SBC offered a forum to a small number of scientists working in biochemistry and allied areas in the country. At the annual meeting in Kolkata in 1964, the attendance was about 100. The number rose to 800 in 1980 at the golden jubilee meeting in Bangalore organized jointly with Federation of Asian and Oceanic Biochemists (FAOB). SBC organized the International Union of Biochemistry and Molecular Biology Congress in Delhi (1994). SBC always played an active role in assisting the progress of biochemistry. This I highlighted in a perspective talk on the role of professional societies in biochemical education[6] at the FAOB meeting in Bangkok (1984). Kagawa bemoaned at the same meeting that the number of Japanese speakers in international fora was less than it deserved. A similar analysis done at the SBC-platinum jubilee meeting with about 500 attending at JNU (2006), showed that only 15% of the invited symposia speakers were from universities, and without those from the host-JNU, it was only 5%. Decrease in university-based research activity is obvious. This is part of the crisis in teaching and research in the universities, ably analysed

recently by Hasnain[7], which has now reached alarming proportions. This needs correction soon as the scientific strength of a country ultimately depends on the quality of training in the university campuses.

Finally, I would like to touch upon a short-lived education programme taken up by SBC. A team of four young (at that time) enthusiasts, K. Muralidhar, V. Sitaramam, D. Chatterji and K. Kannan came up with the idea of putting together active workers and research scholars in the country for two days to discuss the problems faced in the laboratories in experimental work. This experiment was carried out for 6 years during 1980–85, two days before the annual meetings of the SBC. About 300 young scientists in all attended these meetings at their cost. This popular low-cost, high-benefit programme was closed down after an unnecessary, indiscreet remark recorded in *SBC Newsletter* by the then President of SBC. Scientific societies and science academies have a role to play in such short-term training activities to supplement the efforts of universities. Indeed the science academies have pooled their resources, to select and support summer training of young biologists. More of these are welcome, whose effect will be seen only after a few years. Let politics and personalities not hinder the progress.

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